# Crossing Model Driven Engineering and Agility: Preliminary Thought on Benefits and Challenges

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## Preliminary Thought on Benefits and Challenges

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**Abstract.** The constant evolution of software systems has led the software engineering to continually develop new methods and concepts to overcome their development and maintenance. Two main streams have emerged in recent years and become important in current industrial processes: Model Driven Engineering (MDE) and agile methods. MDE promotes the use of models as higher-level artifacts, the separation of concerns and generative approaches. On the other hand, Agility focuses on best practices for programming of software systems and their integration within a development process. Nevertheless, these two trends have evolved independently and must now be unified to make the best of both. We investigate in this position paper the benefits and scope of such unification and we expose our preliminary thought on the challenges ahead for this. The main contribution of this paper is to propose a canvas for the study of this unification, thereby exposing the different challenges. We also hope that this paper will arise interesting discussions within the community about the combination of agile processes and model based paradigms and tools.

## 1 Introduction

Software engineering must evolve to consort with the constant increase of complexity of software based systems. For this, various means are being explored. First of all, the software engineering community constantly strives to changing paradigms of development to master the complexity of systems. Thus, we could see the evolution of concepts in objects, design patterns, components, aspects... More recently, Model-Driven Engineering (MDE) is a new software development approach taking these previous paradigms and focusing on models as first-class entities. Models are sets of objects which types are defined in metamodels. They can also be seen as graphs of objects interconnected by relationships. MDE aims to improve productivity of developers by using Domain Specific Modeling Languages (DSML), maximizing compatibility between systems and platforms, and simplifying the process of design. Thus, using models, developers can manage the complexity of systems at a higher level of abstraction, and with the intrinsic separation of concerns.

On another side, Agility proposes a disciplined project management process, taking into account the complexity but also scalability and market dynamics in this domain. These efforts led to formalized process management such as Scrum[3], or to good practices such as eXtreme Programming (XP)[4]. These concepts emphasize qualitative principles as simplicity, frequent delivery, manage change, good design over formal specification, working software, communication (Abbas et alii [1] sum up characteristics of an agile method in *adaptive, iterative and incremental, people-oriented*).
Both communities cope to the same motivation but evolve independently: no agile good practices is used in a model-based development process, and respectively agile practices and processes are mainly investigated at a low level of abstraction with programming languages. Thus, the combination of these two trends seems crucial to consolidate each of them. The contribution of this paper is to propose a comprehensive framework for showing the various ways to take advantage of the complementarity between agile methods and MDE. Existing works are then put through the framework. We target the integration of agile processes with MDE tooling abilities and induced synergies.
The remainder of this paper is structured as follows. Section 2 presents the two approaches, their combination and the expected benefits. Then sections 3 to 5 investigate the possibles joints between them (agile modeling, agile metamodeling, model-driven agility). Finally, Section 6 conclude the position paper and outline future works.

## 2 Combining MDE and Agility

MDE has become a key feature of software engineering. The use of Domain Specific Modeling Languages (DSML) allows to ease the separation of concerns during the development process. The Y-based process allows to merge concerns that have been developed separately. The success of MDE relies on the facilities which allows to create at a low cost DSML and the associated tooling each time a new concern, or a variation of an existing one, must be handled. Thus MDE splits itself in two conceptual levels: *metamodeling* which is the modeling (i.e. definition) of modeling languages and their associated tools, and *modeling* which consist in using those tools to engineer final applications (cf. Figure 1)[5].
The Agile Manifesto[6] presents agility principles where short iterations, communication, working software are preferred onto specification, norms and formal processes in order to satisfy quality, consumer needs and time line. Figure 2 illustrates main features of this approach.
MDE and Agile methods have appeared separately and evolved on distinct paths. Their apart usefulnesses need to be merged in order to take benefit of potential synergies.

[3] Scrum, cf. http://www.scrum.org
[4] Cf. http://www.extremeprogramming.org
[5] A third level (metametamodeling) offers the tool-supported language to uniformly design DSLs but still out of scope of this paper
[6] Cf. http://agilemanifesto.org

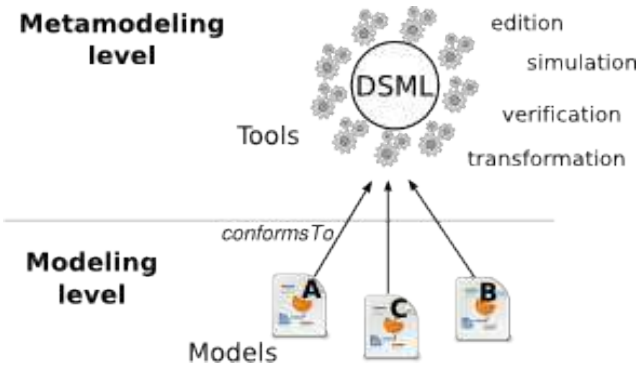


**Fig. 1.** MDE Principles

Some authors tried to weave agile methods and MDE. Most of them have commuted what they considered the most important agile practices or processes into the model-driven approach. The main critic on those works is the lack of investigation on underlying effects and benefits each of the two approaches bring and the synergies we may expect from a good effective merging (see as an example Rumpe who attempts to mix XP principles and UML tooling [2]). Our goal is to amalgamate agiles methods and MDE in a way we would get an alloy with better properties than the addition of each approach.

From the cross-fertilization of agile methods and MDE, we can expect some benefits like agility at a higher level of abstraction, early & formal verification, flexible human-oriented software engineering, etc.

We present in Figure 3 a canvas combining agile processes (and their associated best practices) and MDE: three kind of people are concerned (tool/domain developers, modelers, and end users) to produce two different applications (domain tools and final system). A first agile process takes place at the meta level where metamodeling team has a DEV role and modeling team acts as the user-side expert (called *Product-owner* in Scrum[7]) interacting in short iterations to design and implement domain tools (a metamodel and its related editor and transformations). A second level uses models into its agile process to help producing the final

[7] Cf. http://www.scrum.org/storage/scrumguides/Scrum%20Guide.pdf p. 7

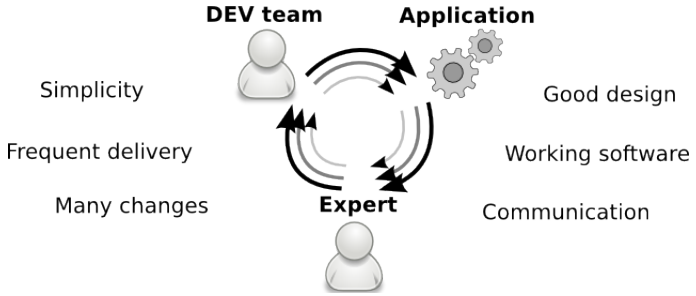


**Fig. 2.** Agile Principles

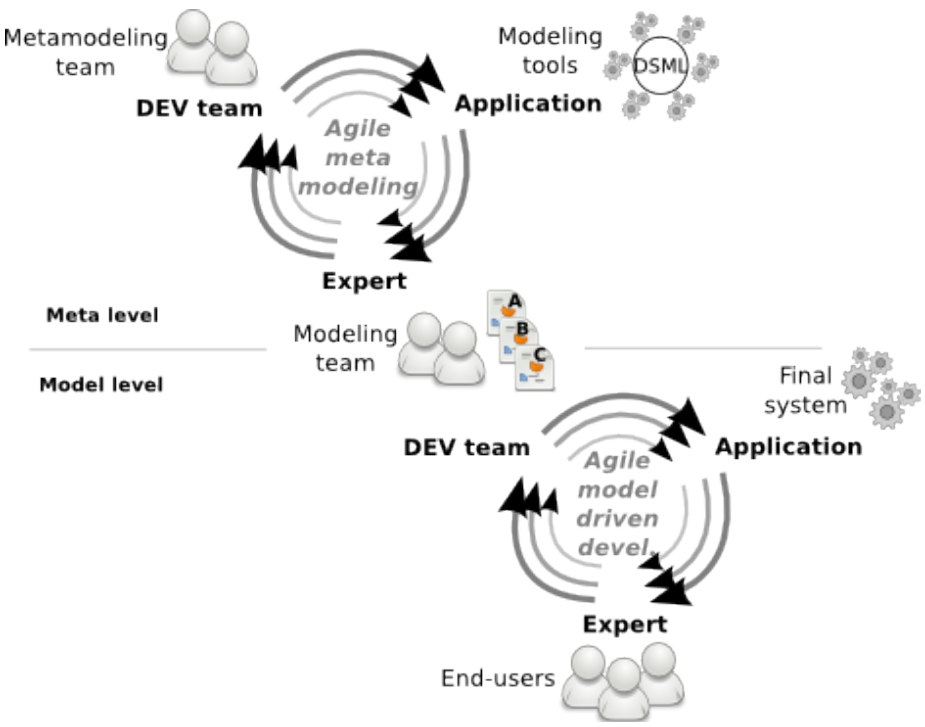


**Fig. 3.** Combining MDE and Agile Methods

application or system; the modeling team here has the DEV role and end-users act as product-owners/experts of their domain.
The unification we propose raises challenges to cross-fertilizes agile approaches and MDE. Taking into account the duality of modeling and metamodeling levels, we consider in this paper three kind of relationships between agile methods and MDE:

- How could agility be introduced in modeling tasks?
- How could agility enhance engineering of DSML?
- How could modeling have benefits in agile processes?

Each of these questions will be addressed in the following sections. For each, we attempt to list corresponding challenges with existing related works and current issues.

## 3 Agility in Modeling

Modeling is often used to do once-for-all the whole conception work in the rigid water-fall software engineering process, delaying all the implementation. Thanks to the MDE approach, the modeling tasks are extending their use field in software engineering, bringing services like simulation or verification.
How can those mind-intensive works be enrich by agile methods? Which kind of facilities can agility offer to modeling teams and processes? A first

answer has been done by Scott Ambler with his *Agile Modeling* book [3]. But his proposals did not take in account the metamodeling level (which was in its early stages) and was critical about Executable UML (which was immature at that time).
As a deeper answer, we investigate in this section the challenges underlying agile modeling according to the recent evolutions of MDE.

### 3.1 Test-Driven Modeling

One of the most popular agile approaches for developers is the Test-driven practice. It consist in writing tests before coding in order to stress the code when it is written, with an additional benefit in hunt of regressions which may occur when you correct or refactor some parts of existing source. How can we introduce in modeling tasks this way of stressing software artifacts before they exist?
In an attempt of tool support Test-Driven Modeling, Hayashy et al. [4] propose their SMART tool to enable test-driven on the development of UML models. SMART includes an action language to specify test cases and a tracing tool to provide feedback between failed tests and model under development. The tool supporting test-driven modeling is interesting but limited to the UML metamodel. Rumpe [5] investigates development of models that describe tests. It uses some of the UML diagrams in order to define tests for an Object-Oriented system.
However, no general approach for DSML seems to be defined to support test-driven modeling. Thus, we need to inspect the problematic of test-driven tool support for DSML. We may expect light-footed tools to support on design models non-regression, automated testing, continuous integration, etc. A central feature would be DSMLUnit equivalent of the well-known but simple JUnit which did a lot for acceptation of test-driven approach by coders.

### 3.2 Short cycles & working software

Emphasis of agile methods on short cycles is motivated by the quest of multiple confrontations of application under development to its final users. Working software is the primary measure of progress in agile methods.
Models have been initially introduced for analysis drawing to help capturing requirements. As documentation artifacts they do not satisfy agility principle of working software. Recently, model execution become a key issue in modeling activities, mainly for *Early V&V*[8].
Mellor presents Executable UML [6] as a mean to suppress the *verification gap*[9] in modeling process. Despite Executable UML models can

[8] V&V stands for *Verification and Validation* that respectively consist in checking that we are building the product right, and we are building the right product. *Early V&V* attempts to do V&V earlier in the development process, at a higher level, where models embed separate concerns.

[9] Verification gap is the delay between writing of documents to specify a system to build and verification by the customers on a running application.

be executed since their beginning there is few uses of short cycles in modeling. Executable UML has been enhanced by Foundational UML [7], which is an executable subset of UML language to define semantics of systems. Some works have also been done on *models@runtime* (see Computer special issue [8]), considering models as final artifacts. This new and emerging field aims to use model-driven techniques for validating and monitoring run-time behavior of computer systems. But those works (e.g., Morin et alii [9]) put their interest on systems in production. This means they focus use of models in applications which have been finished and delivered. Finally, an early work of Boger et alii [10] presents a first try in adapting agile methods (eXtreme Programming) to UML modeling. But the way they run models does not appear clearly.
There is an open question about close and frequent interactions between modeling teams and final users, and about corresponding tooling of DSMLs. Using executable models during the development process for frequent working software delivering is always an open issue. It is specially the case for our goal of executable models into agile short cycles in order to interact with end-users. Two key issues arise. The first one consists on automatic and frequent merging of models for all considered concerns, to be able to deliver a final executable model, representing the whole system. Moreover, short iterations providing frequent working softwares needs to consider partial models for the weaving of the separate concerns.

### 3.3 Modeling process modeling

Agile practices rely on structured (despite evolving) sets of tasks and corresponding managing tools which could be more or less formal and aided by computer applications. Modeling tasks could have benefits of being managed through an agile way if a process tool helps modeling it. Zhang [11] proposes a modeling process centered on a Test-Driven approach. His approach of Test-Driven Modeling (TDM) uses Message Sequence Charts (MSCs) as test cases in a workflow from system building requirements specification to target platform testing of generated system. Beside its process model of modeling activities, Zhang introduces with TDM an agile feature (eXtreme Programming test-driven approach) in the modeling heavy weight process, giving it a verification enhancement but without driving it to a more agile way of doing it.
We always need to formalize what should be an agile modeling process. We may look at current agile coding processes like Scrum to inspire a starting base for the definition of a corresponding modeling process.

### 3.4 Human centered modeling

Agile approach puts a deep focus on the human. Both developers, end-users and experts are the main parts of the processes. All agile methods are centered of them or imply them as actors and deciding entities. Agile initiators have make many efforts in order to solve human problems together with enhance people investment in software building process.

In contrast model-driven approaches tend to replace human fallibility by tooling or programs each time it is possible. So MDE specialists have to investigate deeply this question instead of wrapping it by computer-side solutions.
To the best of our knowledge, we did not find any corresponding research works. An explicit integration of end-users in modeling process need to be investigate as research effort is mainly put on automation and corresponding removing of human from as much as possible software engineering processes and tasks.

### 3.5 Quality metrics for modeling

Agile teams (and subsequent processes) are self-controlled relying on useful ad-hoc indicators to estimate the current state of their work in a visual manner (like Scrum tasks board). Modeling activities currently lacks on-the-fly metrics and measurements of quality which could be used in the agile way of management. One specific need is the ability of splitting a modeling activity in small sub-tasks a modeling team can then follow daily on the tasks board in the Scrum manner.
Some works have been done on models measurement. Monperrus et al. [12] propose a generic MDE approach of model measurement to declare metric specifications. Vénisse [13] makes an attempt to verify UML models and their compliance with design standards. But those works put their interest on structural quality of final models. They do not inform about current reminding work.
We need to find metrics which both are quality-oriented and usable in agile processes. We also have to investigate how to identify work to do in models during modeling in order to insert such metrics in continuous integration systems like Hudson[10] which are intensively used in agile processes.

## 4 Agility in Metamodeling

MDE may be summarized with: *"Better than writing programs, write programs which write programs"* (dixit Doug Schmidt). MDE proposals meet the need of automation in software engineering: reduce human errors and boring tasks, generate tests and code. The modeling tasks depend on the availability of appropriate DSML-based tools such as textual or graphical editors, simulators, and model transformations (e.g., compilers). Such a tooling of a domain relies on the metamodeling activity. How the agile approach can help the development of DSML-based tools? But designing and implementing development tools is always developing; it raises similar challenges (e.g., quality, costs and delays). We may expect that an agile development of DSML-based tools will be useful in the MDE tooling process, where humans develop the modelers, model transformations, generators, etc which generate source code of final artefacts. In this section we consider how agile approach can be applied to metamodeling tasks and teams.

[10] Cf. http://hudson-ci.org/

### 4.1 Test-Driven Metamodeling

As seen in figure 3, an Agile Model-Driven Development (AMDD) implies frequent changes for modeling team; these changes may impact the tools designed and built at metamodeling level. In order to satisfy the agile principles, the metamodeling level must accept frequent changes and delivering within short cycles. Such constraints imply a Test-driven approach on the DSML and its tooling.
The use of a test-driven approach in metamodeling has been investigated by two works: Giner and Pelechano [14] capture requirements of model-to-model transformations in corresponding test cases; Kehrer and Wenzel [15] investigate testing of model transformations with respect to Test-Driven Development principles. Both are dedicated to development of model transformations. The first one offers a tool when the second one proposes a method, but they lack to address the whole subject of test-driving the metamodel design and its associated tools development (where transformations are one part).
Future research work should hardly consider the testing during short iterations onto the metamodel and the tools with deep attention on both expert validation and non-regression questions.

### 4.2 Capture Expertise

A big issue in metamodeling is the distance between tool engineer skills and each end-user application domain. DSML means expertise in the targeted application trade together with metamodeling skills for a tooling engineer. Agility focus on humans and communication can help catch the untold specificities of a domain and capture them into the corresponding DSML, using short cycles.
N. Allen et alii [16] examine some features the modeling tools may have in order to support the domain expert in performing model verification, validation and testing. They focus on the tooling of modeling activities and the underlying tool properties.
The capture of the domain itself with short iterations and communication between expert and metamodel developer remains to be investigated.

### 4.3 Relax DSML Tooling Rigidity

Modeling tools are syntacticaly dependent to their DSML. It introduces rigidity in the whole MDE process. Once a tool has been developed onto a given metamodel, changes in the last one may be a problem in the first one. As an example, the GMF[11] modeler can be regenerated each time its metamodel changes but a compiler or a textual syntax grammar must be updated with hands (and a large amount of debugging work).
To the best of our knowledge, we do not found related work of this challenge. As an example the design of Executable UML [6] has consumed a huge amount of resources. We need to lighten the same process for

[11] The Eclipse Graphical Modeling Framework, cf. http://www.eclipse.org/gmf/

any DSML by providing a tool supported semantic engineering, in order to easily define DSML tools by generation of simulators, compilers, modelers, etc. So there is a need of investigation about techniques like generative approaches taken into account DSML semantics.

## 5 Model-Driven Agility

Agile processes and methods suffer some weaknesses such as the implicit constraints Turk et alii listed [17] (e.g. *Limited support for developing large, complex software*). Those authors later identified [18] several underlying assumptions (e.g. *Team Experience Assumption: Developers have the experience needed to define and adapt their processes appropriately.*). How could a model-driven approach relax some of these assumptions and limits? We investigate in this section the use of both modeling and metamodeling in order to deal with those agile process weaknesses.

### 5.1 Model-Based Testing

Agility relies on testing for verification of produced code to balance the emphasis on empirical work and informal management of the development process. The ability of metamodeling to generate or validate test cases and test models from design models may offer Agility a substantial help in its most critical feature (tests counter the inherent weakness of non formal processes).
The domain of Model-Based Testing (MBT) has been deeply investigated by MDE community. Briand and Labiche [19] use UML artifacts as system requirements in order to extract tests from them. Pretschner et alii [20] empirically evaluate such approaches based on models and tests automation. Utting and Legeard address current practices in their book [21]. As additional examples, some deepening have been done about test generation from metamodel [22] and automatic validation of test cases [23]. The first work propose partitioning strategies to contain the number of generated test models together with a mutation analysis approach to automatically verify their effectiveness. The second paper tunes a set of rules for assessing the quality of input models with regards to the tested transformations together with a framework assisting the users in improving those models. They introduce the ability of modeling tools to help developers to work in an agile (test-driven) way. But until now MBT is done in a heavy weight manner inside the traditional Y-based processes. We have to expect high-level agility by allowing more flexible, quicker and light-footed tooling for MBT (similarly to the introduction of JUnit in IDEs) to rapidly react to each requirement evolution at model level.

### 5.2 The best skills at each level of agility process

Agility emphasizes the importance of small teams working on the final system by small increments. Effective software engineering addresses large computer systems involving thousands of users implying hundred

of developers during several years often in maintenance activities. One solution is to separate concerns between each element of the targeted system. Engineering through models enhances such a separation: each aspect of an application can be designed and verified in its specific domain. Platform aspects or performance constraints can then be added by model transformations or weaving into domain certified models to produce final application by code generation. Metamodeling and associated tools may satisfy this separation of concerns with agility at each level: at the business level the corresponding DSML is close to the final users; the technical part of the application can be done by developers having tools for their appropriate know-how; the integration to the targeted platforms can be held by highly skilled engineers.
No works have investigate this slicing of agility using metamodeling. How DSML may benefit to the introduction of agility? We may have to identify the different concerns which could be separated by metamodeling approach. A study of the different skills involved in software engineering could also be helpful.

### 5.3 Agility at a higher level of abstraction

Software Engineering gains climbing to higher level of abstraction. DSML are a recent new step in this search for abstraction, adding their stone to the unceasing evolution of software engineering paradigms. Capturing the essence of a domain, a DSML capitalizes knowledge upstream in the development process. But agile approaches are focused on the source code. Using agile methods at higher level can help validating abstract view of the problem to solve, giving more strength to the whole engineering work.
The question of Agility at high level of abstraction has not been really investigated. Researchers may focus on the content of high abstraction levels before they try to introduce agile practices and processes in those areas. Agility features like interaction, short cycles, etc. need a good identification of participants and tasks at the different levels.

### 5.4 On-the-fly DSLs

An agile approach and corresponding practices applied to metamodeling make possible the quick design and implementation of small domain specific metamodels dedicated to an encountered problem within the development activity. Such an on-the-fly language could help solving an unexpected difficulty by ability to model and simulate the underlying problem when it is detected with few efforts and low resource consumption. Such lighter and more versatile use of metamodeling increases its interest for agile processes.
To our best knowledge, no research works have been done on such a use of DSML technologies. A first step of investigation would be a survey of agile practices in order to detect the kind of pinpoint needs could be covered by an ad-hoc DSML and corresponding tooling. The listed uses could also drive in next step progress in DMSL tools generation.

### 5.5 Agile Processes Modeling

Currently, agile methods are most often informally and textually described. Unfortunately, best practices and processes are not sufficiently formalized allowing to analyze, evaluate, compare, or even partially automate such agile methods. This is an important need to allow acceptance of such techniques and to assess the real gains that will involve. Process engineering community recently raised this issue in the Semat Initiative[12].
Ability of MDE to describe a domain and build corresponding tools can be used to model agile methods, and to equip agile teams with dedicated tools. We found existing process modeling languages such as SPEM (*Software Process Engineering Meta-Model*) [24] but they are not used for this purpose.
There is a need to tailored such modeling languages for using in agile processes, with a main focus to put on the corresponding tooling.

## 6 Conclusion and Perspectives

We investigate in this paper a more flexible way for software system development, combining MDE and agile methods. For this purpose, we propose a canvas relying on Agile processes and practices at both modeling and metamodeling levels. Following this cross-fertilization canvas, we explore the expected benefits and associated challenges.
This paper brings preliminary thoughts opening challenging perspectives. According to our canvas, the integration of agile methods in metamodeling seems essential to enable efficient agile modeling, while agile methods can benefit of MDE.

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